Silicon photonics for neuroscience

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Overview:

Optogenetics offers a way to interrogate the workings of the brain; it provides tools to inhibit or activate neurons to test the causal neural substrates of behavior and brain function in general. The ability to optically stimulate neurons in arbitrary spatiotemporal patterns - (critical for decoding of neural substrates) has not yet been possible due to the limited re-configurability of traditional optical technologies. We demonstrate a platform for creating spatio-temporal patterns based on active silicon photonics technology that overcomes the limited reconfigurability of traditional optics by confining light which increases the sensitivity to small refractive index changes in the optical structure. The platform consists of an implantable silicon probe consisting of a 1x8 micro fabricated switch fabric that determines the spatial distribution of light beamed out of the probe. In order to demonstrate the potential of the platform and its ability to produce correlated light patterns with neural activity patterns in vivo, we packaged the device with a tungsten electrode array placed near the output gratings with a resolution of <50 microns and implanted it in a mice. We show that this device can control neural activity in vivo independently across beams and with high temporal precision.

Bio:

Professor Michal Lipson joined the Electrical Engineering faculty at Columbia University in July 2015. She completed her B.S., M.S., and Ph.D. degrees in Physics at the Technion in 1998 followed by a Postdoctoral position at MIT in the Materials Science Department till 2001. In 2001 she joined the School of Electrical and Computer Engineering at Cornell University. She was named Cornell Given Foundation Professor of Engineering in 2013. Lipson was one of the main pioneers in the field of silicon photonics and is the inventor of several of the critical building blocks in the field including the GHz silicon modulator. She holds over 20 patents and is the author of over 200 technical papers. Prof. Lipson held several leadership positions in the scientific community including, IEEE Photonics society board of directors member, co-organized numerous symposia and sessions in OSA conferences. She chaired and served on numerous committees including the Micro and Nanophotonics Subcommittee of CLEO, which she chaired 2006-2009. She has served as a topical editor (integrated photonics) for Optics Letters and served as a guest editor for IEEE Journal of Selected Topics of Electronics. She is currently serving on the board of directors for two international photonics centers, two startup companies and on the Rice ECE Advancement Committee. She is a co-founder of PicoLuz, a company specializing in nonlinear silicon photonic components. Professor Lipson's honors and awards include the MacArthur Fellow, Blavatnik Award, IBM Faculty Award, and the NSF Early Career Award. She is a fellow of OSA and IEEE. In 2014, and in 2015 she was named by Thomson Reuters as a top 1% highly cited researcher in the field of Physics.